Y1: 2.0 mm ≥ Y1 ≥ 0 mm

The relationship of C1, C2 and C3, to each other is as follows, C1>C3>C2. C1, C2 and C3 are shown on Figure 7B.

According to the above results, this new filter technology can be applied to many filters and duplexers which are of a smaller size with higher electrical performance than currently available filters. The foregoing merely illustrates the principles of the present invention. Those skilled in the art will be able to devise various modifications, which although not explicitly described or shown herein, embody the principles of the invention and are thus within its spirit and scope.

WHAT IS CLAIMED IS:

1. A filter comprising:

a block of dielectric material having a top surface, a bottom surface, two opposing first side-walls connecting said top surface to said bottom surface along the width of said block and two opposing second side-walls connecting said top surface to said bottom surface along the height of said block;

two input/output pads on one of said first side walls;

at least three holes spaced along the width of said block and extending through said block from said top surface to said bottom surface, wherein at least one of said at least three holes which is located on the end of the three holes, and where said at least one hole's center is off a line bisecting the remaining two of the at least three holes;

conductive material substantially covering said bottom surface said first and second

side-wall surfaces and said inner surfaces of said at least three holes;

said each holes have patterns of conductive material on said top surface, surrounding said holes;

said center of said off line hole is a distance Y1 from a center of an hole adjacent to the off line hole, said distance Y1 being perpendicular to the filter's first side walls;

said center of said off line hole is a distance X1, from the center of said adjacent hole, said distance X1 being parallel to the filter's first side walls;

a first pattern of conductive material between said off line hole and the adjacent hole, where said first pattern comprises a first arm of conductive material parallel to the edge of the conductive material of the off line hole and parallel to the filter's first side walls, a second arm of conductive material perpendicular to said first arm of conductive material, and a third arm of conductive material parallel to the first arm of conductive material and perpendicular to the second arm of conductive material said first pattern of conductive material is connected to the first of said input/output pads on one of said first side walls;

said off line hole has a pattern of conductive material surrounding said hole, said edge of said off line hole's pattern of conductive material has a capacitance C2 from the edge of conductive material surrounding the adjacent hole, where C2 is the capacitance between two opposite edges of said offline hole's pattern of conductive material and said adjacent hole's pattern of conductive material;

where said off line hole is next to the first arm of conductive material where capacitance C1 between the conductive material surrounding said off line hole and the first

arm of conductive material, where C1 is the capacitance between the off line hole's pattern of conductive material and said first pattern of conductive material);

a second pattern conductive material opposite the first pattern of material, where said second pattern has a width, W, and a length, L, said second pattern is connected to the conductive material on one of the first side walls; and

a capacitance C3 which is the capacitance between said pattern of hole adjacent to off line hole and said first pattern; and

a third pattern of conductive material between the fifth and sixth holes where said third pattern is connected to said second input/output pad.

2. The filter of claim 1 wherein W: 0.5 mm $\geq$ W $\geq$ 0.1 mm, L: 3.0 mm $\geq$ L $\geq$ 0.5 mm, X1: 4.0 mm $\geq$ X1 $\geq$ 1.0 mm and Y1: 2.0 mm $\geq$ Y1 $\geq$ 0 mm.

3. The filter of claims 1 and 2 wherein **C1>C3>C2.**

4. A duplexer filter comprising:

a block of dielectric material having a top surface, a bottom surface, two opposing side-walls connecting said top surface to said bottom surface along the width of said block and two opposing side-walls connecting said top surface to said bottom surface along the height of said block;

three input/output pads on one of said side-walls;

multiple holes spaced along the width of said block and extending through said block from said top surface to said bottom surface, wherein a first hole is located at a first

location and where said first holes-center is off a line bisecting the remaining holes;

conductive material substantially covering said bottom surface said side-wall surfaces and said inner surfaces of said holes;

said center of said off line hole is a distance Y1 from a center of a hole adjacent to said off line hole, said distance Y1 being perpendicular to the filter's side walls;

said center of said off line hole is a distance X1, from the center of said adjacent hole said distance X1 being parallel to the filter's side walls;

a first pattern of conductive material connected to one of said side walls, where said first pattern is located between said first off line hole and the next adjacent hole to the first off line hole and has a width W and a length L;

a second pattern of conductive material connected to said first input/output pad, where said second pattern is located between a non-off line hole of lower band and the next adjacent non-off line hole of higher band;

where said first off line hole is next to the second pattern of conductive material with a capacitance C1 between the conductive material surrounding said first off line hole and the second pattern of conductive material;

a second capacitance C2 which is the capacitance between the pattern of said next adjacent hole to said first off line hole and said conductive material surrounding said first off line hole; and

a third capacitance C3 which is the capacitance between said second pattern of conductive material and said pattern of said next adjacent hole to said first off line hole.

5. The filter of claim 4 wherein at least two of said holes are transmission poles and

the number of transmission poles is at least two in each of a higher and a lower band of frequencies.

6. The filter of claim 4 wherein the frequency of the off line hole at the center of said duplexer filter is nearly equal to that of a higher band of frequencies.

7. The filter of claim 5 wherein the frequency of the off line hole at the center of said dupiexer filter is nearly equal to that of a higher band of frequencies.

8. The filter of claim 4 wherein W: 0.5 mm $\geq$ W $\geq$ 0.1 mm, L: 3.0 mm $\geq$ L $\geq$ 0.5 mm, X1: 4.0 mm $\geq$ X1 $\geq$ 1.0 mm and Y1: 2.0 mm $\geq$ Y1 $\geq$ 0 mm.

9. The filter of claim 5 wherein W: 0.5 mm $\geq$ W $\geq$ 0.1 mm, L: 3.0 mm $\geq$ L $\geq$ 0.5 mm, X1: 4.0 mm $\geq$ X1 $\geq$ 1.0 mm and Y1: 2.0 mm $\geq$ Y1 $\geq$ 0 mm.

10. The filter of claim 6 wherein W: 0.5 mm $\geq$ W $\geq$ 0.1 mm, L: 3.0 mm $\geq$ L $\geq$ 0.5 mm, X1: 4.0 mm $\geq$ X1 $\geq$ 1.0 mm and Y1: 2.0 mm $\geq$ Y1 $\geq$ 0 mm.

11. The filter of claim 7 wherein W: 0.5 mm $\geq$ W $\geq$ 0.1 mm, L: 3.0 mm $\geq$ L $\geq$ 0.5 mm, X1: 4.0 mm $\geq$ X1 $\geq$ 1.0 mm and Y1: 2.0 mm $\geq$ Y1 $\geq$ 0 mm.

12. The filter of claims 4, 5, 6, 7, 8, 9, 10 and 11 wherein C1>C3>C2.

13. The filter of claim 4 where said offline hole is after a line of four holes to the right of said offline hole and four holes to the left said offline hole.

14. The filter of claim 4 where there are two offline holes, the first offline hole having three holes to the left and four non-offline holes to the right of its location, with said second offline hole to the right of the last of said non-offline holes.

15. The filter of claim 4 where there are three offline holes, one on each of the two ends of said filter and the third to the right of two non-offline holes and to the left of three non-offline holes.

16. The filter of claim 4 where there are two offline holes with one offline hole on the left end of said filter and the offline hole having two non-offline holes to the left of said second offline hole and three non-offline holes to the right of said second offline hole.